FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR
APV31511	09/914645

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/01950	March 2, 2000	March 3, 1999

TITLE OF INVENTION

PROCESS FOR THE WALL IRONING OF A PRODUCT IN SHEET FORM AND A WALL IRONING TOOL

APPLICANT(S) FOR DO/EO/US

Corus Staal BV

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☐ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

Confirmation Claim for Priority

THE APPLICANT HEREWITH PETITIONS THE PTO TO EXTEND THE TIME FOR RESPONSE AS REQUIRED TO MAKE THE ATTACHED DOCUMENT TIMELY FILED. PLEASE CHARGE THE COST THEREOF TO DEPOSIT ACCOUNT 19-4375

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/914645	PCT/EP00/01950	APV31511

24. The following fees are submitted:.	CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :	
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1000.00**	
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**	
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**	
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**	
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**	
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$860.00**
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	26 - 20 =	6	x $18.00	**$108.00**
Independent claims	3 - 3 =	0	x $80.00	**$0.00**
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**

TOTAL OF ABOVE CALCULATIONS =	**$968.00**
☐ Applicant claims small entity status. (See 37 CFR 1.27). The fees indicated above are reduced by 1/2.	**$0.00**
SUBTOTAL =	**$968.00**
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +	**$0.00**
TOTAL NATIONAL FEE =	**$968.00**
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐	**$0.00**
TOTAL FEES ENCLOSED =	**$968.00**
	Amount to be: refunded $
	charged $

a. ☒ A check in the amount of **$968.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **19-4375** A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Anthony P. Venturino
Reg. No. 31,674

STEVENS, DAVIS, MILLER & MOSHER, LLP
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THE APPLICANT HEREWITH PETITIONS THE PTO TO EXTEND THE TIME FOR RESPONSE AS REQUIRED TO MAKE THE ATTACHED DOCUMENT TIMELY FILED. PLEASE CHARGE THE COST TO DEPOSIT ACCOUNT 19-4375

STEVEN DAVIS MILLER & MOSHER, L.L.P.

Anthony P. Venturino
SIGNATURE

Anthony P. Venturino
NAME

31,674
REGISTRATION NUMBER

August 31, 2001
DATE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

VAN DER AA et al

Serial No.: National Stage of Serial No. PCT/EP00/01950

International Filing Date: 2 March 2000

For: PROCESS FOR WALL IRONING OF A PRODUCT IN SHEET FORM AND A WALL IRONING TOOL

PRELIMINARY AMENDMENT

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

Prior to the calculation of the filing fee, please amend the above-identified application as follows.

IN THE SPECIFICATION

Please amend the specification as follows. A set of specification pages marked up to show these changes is attached (ATTACHMENT II).

Page 1, in the first line after the Title, insert the following:

--Field of the Invention--.

after line 10, insert the following heading --Background of the Invention--.

Page 1, after line 28, insert the following:

-- Brief Description of the Figure

The sole figure shows results of the correlation between the forming rate (ds/dt in s^{-1}), plotted on the horizontal axis, and yield stress σ_v in MPa, plotted on the vertical axis, and the prevailing pressure P_o in MPa on all sides.

Summary of the Invention--.

Page 2, after line 2, insert the following

-- Detailed Description of the Preferred Embodiments --.

IN THE CLAIMS

Please amend the following claims. A marked up set of claims showing the amendments is attached (ATTACHMENT I).

REMARKS

Claims 1- 26 are pending.

This Preliminary Amendment makes editorial revisions to the specification.

An Information Disclosure Statement and PTO-1449 directed to the art of record in the parent case are submitted herewith.

Early and favorable consideration of this application are respectfully requested.

Respectfully submitted,

Date: Aug 31, 2001

By: ______________________
Anthony P. Venturino
Registration No. 31,674

APV
ATTORNEY DOCKET NO. APV 31511

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ATTACHMENT I - Marked up Claims

1. (Amended) Process for the wall ironing of a product in sheet form, which is formed from a metal sheet coated on at least one side with a layer of plastic, comprising

moving the product with a plastic coating layer in a direction of movement along a forming surface of a [the] wall-ironing tool [comprising a forming surface which the product with a plastic coating layer moves along] during the wall ironing, [and] the forming surface being at an entry angle with respect to the direction of movement of the product, [characterized in that]

wherein the entry angle varies over the length of the forming surface, in the direction of movement of the product past the forming surface, this entry angle being smaller in a starting zone of the forming surface than in the subsequent zone thereof.

2. (Amended) Process according to Claim 1, [characterized in that] wherein the forming surface in an end zone is again at a smaller entry angle than in the intermediate zone.

3. (Amended) Process according to Claim 1 [or 2], [characterized in that] wherein the forming surface, following the zone with the largest entry angle, comprises a so-called land zone, with an entry angle = 0°.

4. (Amended) Process according to Claim 2 [or 3], [characterized in that] wherein the entry angle has a fixed value in each of the zones.

5. (Amended) Process according to Claim 2 [or 3], [characterized in that] wherein there is a smooth change in the entry angle over the length of the forming surface.

6. (Amended) Process according to Claim 5, [characterized in that] wherein the transitions between successive zones, and/or such zones themselves run in the form of an arc of a circle.

7. (Amended) Process according to [one of the preceding claims] Claim 1, [characterized in that] wherein the wall-ironing tool comprises a plurality of forming surfaces.

8. (Amended) Process according to Claim 1 [one of the preceding claims], [characterized in that] wherein the wall-ironing tool comprises a plurality of wall-ironing rings.

9. (Amended) Process according to Claim 1 [one of the preceding claims], [characterized in that] wherein 60 to 90% of the total wall thinning is produced by the corresponding forming surface in the zone running at the largest entry angle, the so-called main zone.

10. (Amended) Process according to Claim 9, [characterized in that] wherein 10 to 30% of the total wall thinning is produced by the corresponding forming surface in the starting zone.

11. (Amended) Process according to Claim 9 [or 10], [characterized in that] wherein less than 30% of the total wall thinning is produced by the corresponding forming surface in the end zone.

12. (Amended) Process according to Claim 1 [one of the preceding claims], [characterized in that] wherein the length of the starting zone and/or of the end zone, under otherwise identical conditions, is set in such a way that the plastic coating is not torn off the metal sheet as a result of the wall ironing.

13. (Amended) Process for the wall ironing of a product in sheet form, which is formed from a metal sheet coated on at least one side with a layer of plastic, comprising

moving the product with a plastic coating layer in a direction of movement along a forming surface of a [the] wall-ironing tool [comprising a forming surface which the product with a plastic coating layer moves along] during the wall ironing, [and] the forming surface being at an entry angle with respect to the direction of movement of the product, [characterized in that,]

wherein in a zone of the forming surface which runs at the largest entry angle, the plastic layer is held under an elevated pressure P_0 (in MPa) on all sides, and [that] the plastic used for the coating layer is characterized by values of the parameters μ (no units); τ_0 (in MPa) and A_0 (in sec), [as defined in the description,] which are as follows:

$\mu \geq 0.03$; $\tau_0 \geq 0.60$ and $A_0 \geq 2.0 \times 10^{19}$.

14. (Amended) Process according to Claim 13, [characterized in that] wherein the parameters μ, τ_0 and A_0 are as follows: $\mu \geq 0.047$; $\tau_0 \geq 0.90$ and $A_0 \geq 3.0 \times 10^{19}$.

15. (Amended) Process according to Claim 13 [or 14], [characterized in that] wherein the plastic used is also characterized by values for the parameters $T_{g,\,1\,atm}$ and $T_{g,\,600MPa}$ (in °C) [, as defined in the description,] which are as follows: $T_{g,\,1\,atm} \geq 30°C$, and $T_{g,\,600MPa} \geq 200°C$.

16. (Amended) Process according to Claim 15, [characterized in that] wherein the parameter $T_{g,\,1\,atm}$ is as follows: $T_{g,\,1\,atm} \geq 70°C$.

17. (Amended) Wall-ironing tool[, in particular] comprising a wall-ironing ring, comprising a forming surface, along which a sheet-like product can be moved in a direction of movement during the wall ironing, which forming surface is at an entry angle with respect to the direction of movement of the product, [characterized in that] wherein the entry angle varies over the length of the forming surface, in the direction of movement of the product, this angle being smaller in a starting zone of the forming surface than in the subsequent zone thereof.

18. (Amended) Wall-ironing tool according to Claim 17, [characterized in that] wherein the subsequent zone is an intermediate zone and the forming surface further comprises [in] an end zone subsequent to the intermediate zone which is again at a smaller entry angle than in the intermediate zone.

19. (Amended) Wall-ironing tool according to Claim 17 [or 18], [characterized in that] wherein the forming surface further comprises an end zone, subsequent to the intermediate zone, and between the intermediate zone and the end zone there is a land zone with a length of between 0.3 and 1.5 mm.

20. (Amended) Wall-ironing tool according to one of [Claims 17-19] Claim 17, [characterized in that] wherein the entry angle has a fixed value in each of the zones.

21. (Amended) (Amended) Wall-ironing tool according to [one of Claims 17-19] Claim 17, [characterized in that] wherein there is a smooth change in the entry angle over the length of the forming surface.

22. (Amended) Wall-ironing tool according to Claim 21, [characterized in that] wherein the transitions between successive zone, and/or the zones themselves, run in the form of an arc of a circle with a radius of a length of between 0.1 and 10 mm.

23. (Amended) Wall-ironing tool according to [one of Claims 17-22] Claim 17, [characterized in that] wherein the [main] zone having the largest entry angle, which is named a main zone, forms between 60 and 90% of the transverse dimension of the forming surface, transversely with respect to its longitudinal direction.

24. (Amended) Wall-ironing tool according to Claim 23, [characterized in that] wherein the starting zone forms between 10 and 30% of the transverse dimension of the forming surface.

25. (Amended) Wall-ironing tool according to Claim 23 [or 24], [characterized in that] further comprising an end zone, subsequent to the intermediate zone, wherein the end zone forms less than 30% of the transverse dimension of the forming surface.

26. (Amended) Wall-ironing tool in the form of a wall-ironing ring, according to [one of Claims 17-25] Claim 17, [characterized in that] wherein this wall-ironing ring is under a radial prestress on its outer circumferential surface, due to a strip or wire which has been wound around [it] the ring under stress.

ATTACHMENT II - Marked up Specification Pages

PROCESS FOR THE WALL IRONING OF A PRODUCT IN SHEET FORM, AND A WALL IRONING TOOL

Field of the Invention

The invention relates to a process for the wall ironing of a product in sheet form, which is formed from a metal sheet coated on at least one side with a layer of plastic, the wall-ironing tool comprising a forming surface which the product with a plastic coating layer moves along during the wall ironing, and the forming surface being at an entry angle with respect to the direction of movement of the product. A process of this nature is in widespread use for the production of a can comprising a base and a tubular body, although the invention is not limited to this particular application.

Background of the Invention

The entry angle forms an important parameter in wall ironing. It has been found that with a very small entry angle the spreading force, that is to say the force which acts on the forming surface transversely with respect to the direction of movement of the product, becomes very high. For example, in the case of wall ironing of cans, this may lead to extreme loads being imposed on the wall-ironing ring used, which may consequently be damaged or even break.

Selecting a larger entry angle runs the risk of the plastic layer breaking and being stripped off the metal sheet. This is because a larger entry angle results in a greater longitudinal force being exerted on the plastic layer in the direction of movement, with the result that the stress in the said plastic layer exceeds a fracture limit.

Proposals have previously been made for making the process more suitable for working with plastic-coated metal sheet. In European Patent EP 0,298,560, it is proposed that additional lubrication be used during the wall ironing, and specific entry angles are proposed for successive wall-ironing rings. Nevertheless, there is a continuing need to work with larger entry angles, in order to be able to achieve longer service lives of the wall-ironing tool. The present invention now offers a solution enabling the risk of the plastic layer breaking and being stripped off during wall ironing to be reduced, so that larger entry angles can be used.

Summary of the Invention

The invention is based on making use of the observed fact that many plastics materials exhibit a higher fracture limit during forming as the pressure on all sides increases. The appended figure shows results of the correlation between the forming rate ($d\varepsilon/dt$ in s^{-1}), plotted on the horizontal axis, and the yield stress σ_v in MPa, plotted on the vertical axis, and the prevailing pressure P_0 in MPa on all sides. This figure works on the basis of a polyethyleneterephthalate (PET), with lines illustrating results of model studies and crosses indicating the results of experiments. It can be clearly seen from this figure that the yield stress is considerably higher as the pressure on all sides rises. The object of the invention is therefore to produce a high pressure on all sides at the location where the coated metal sheet is being wall-ironed using a large entry angle,

Brief Description of the Sole Figure

The sole figure shows results of the correlation between the forming rate ($d\varepsilon/dt$ in s^{-1}), plotted on the horizontal axis, and the yield stress σ_v in MPa, plotted on the vertical axis, and the prevailing pressure P_0 in MPa on all sides.

without it being necessary to apply a very high pressure to the entire wall-ironing installation.

Detailed Description of the Preferred Embodiments

The invention therefore consists in the fact that the entry angle varies over the length of the forming surface, in the direction of movement of the product past the forming surface, this entry angle being smaller in a starting zone of the forming surface than in the subsequent zone thereof. The result of [his] this measure is that, in the starting zone with the small entry angle, a high pressure on all sides is built up in the material, and this pressure is maintained during the subsequent forming in the subsequent zone with a larger entry angle. In the zone where the actual forming takes place, a high pressure prevails on all sides, yet nevertheless a relatively low spreading force is exerted on the forming surface (for example a wall-ironing ring).

The high pressure which is generated on all sides in the plastic layer may relax slightly towards the chamber after the wall-ironing tool has been passed, towards the end of the zone with the larger entry angle. This may mean that the fracture stress of the plastic material is reduced again at that location, causing it to fracture and be stripped off by the wall-ironing tool. For this reason, it has proven advantageous for the forming surface in an end zone to again be at a smaller entry angle than in the intermediate zone.

An improvement is also achieved if the forming surface, following the zone with the largest entry angle, comprises a so-called land zone, with an entry angle of 0°. The length of this land zone may be between 0.3 and 1.5 mm.

In one possible application of the invention, the entry angle may have a fixed value in each of the said zones. However, under certain circumstances it may be preferable for the entry angle to change smoothly over the length of the forming surface. This prevents sudden changes in stress in the material to be wall ironed, so that, under certain circumstances, the wall ironing can proceed more successively.

In the preferred embodiment of this smooth change, the transitions between the successive zones, and/or the zones themselves, run in the form of an arc of a circle. Good results are obtained if the radius of this arc is between 0.1 and 10 mm long.

Particularly if the novel process is used for the wall ironing of a product which ultimately acquires the shape of a can, it is advantageous for the wall-ironing tool to comprise a plurality of wall-ironing rings of the type described above. In particular, it has proven advantageous for between 60 and 90% of the total wall thinning to be produced by the corresponding forming surface in the zone which runs at the largest entry angle, the so-called main zone. A further improvement is obtained if between 10 and 30% of the total wall thinning is produced by the corresponding forming surface in the starting zone. Furthermore, it is advantageous, if an end zone is also being used, for less than 30% of the total wall thinning to be produced by the corresponding forming surface in this end zone.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

VAN DER AA et al

Serial No.: 09/914,645

International Filing Date: 2 March 2000

For: PROCESS FOR WALL IRONING OF A PRODUCT IN SHEET FORM AND A WALL IRONING TOOL

SECOND PRELIMINARY AMENDMENT

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

As a supplement to the Preliminary Amendment filed August 31, 2001, Applicant presents a clean set of the claims as amended by that Preliminary Amendment.

IN THE CLAIMS

Please amend the claims to read as follows. Applicant presents this clean set of the claims as amended by the Preliminary Amendment filed August 31, 2001, plus a further amendment to Claim 20. A marked up Claim 20 showing the additional amendment is attached (Attachment A).

1. (Amended) Process for the wall ironing of a product in sheet form, which is formed from a metal sheet coated on at least one side with a layer of plastic, comprising

moving the product with a plastic coating layer in a direction of movement along a forming surface of a wall-ironing tool during the wall ironing, the forming surface being at an entry angle with respect to the direction of movement of the product,

wherein the entry angle varies over the length of the forming surface, in the direction of movement of the product past the forming surface, this entry angle being smaller in a starting zone of the forming surface than in the subsequent zone thereof.

2. (Amended) Process according to Claim 1, wherein the forming surface in an end zone is again at a smaller entry angle than in the intermediate zone.

3. (Amended) Process according to Claim 1, wherein the forming surface, following the zone with the largest entry angle, comprises a so-called land zone, with an entry angle = 0°.

4. (Amended) Process according to Claim 2, wherein the entry angle has a fixed value in each of the zones.

5. (Amended) Process according to Claim 2, wherein there is a smooth change in the entry angle over the length of the forming surface.

6. (Amended) Process according to Claim 5, wherein the transitions between successive zones, and/or such zones themselves run in the form of an arc of a circle.

7. (Amended) Process according to Claim 1, wherein the wall-ironing tool comprises a plurality of forming surfaces.

8. (Amended) Process according to Claim 1, wherein the wall-ironing tool comprises a plurality of wall-ironing rings.

9. (Amended) Process according to Claim 1, wherein 60 to 90% of the total wall thinning is produced by the corresponding forming surface in the zone running at the largest entry angle, the so-called main zone.

10. (Amended) Process according to Claim 9, wherein 10 to 30% of the total wall thinning is produced by the corresponding forming surface in the starting zone.

11. (Amended) Process according to Claim 9, wherein less than 30% of the total wall thinning is produced by the corresponding forming surface in the end zone.

12. (Amended) Process according to Claim 1, wherein the length of the starting zone and/or of the end zone, under otherwise identical conditions, is set in such a way that the plastic coating is not torn off the metal sheet as a result of the wall ironing.

13. (Amended) Process for the wall ironing of a product in sheet form, which is formed from a metal sheet coated on at least one side with a layer of plastic, comprising

moving the product with a plastic coating layer in a direction of movement along a forming surface of a wall-ironing tool during the wall ironing, the forming surface being at an entry angle with respect to the direction of movement of the product,

wherein in a zone of the forming surface which runs at the largest entry angle, the plastic layer is held under an elevated pressure P_0 (in MPa) on all sides, and the plastic used for the coating layer is characterized by values of the parameters μ (no units); τ_0 (in MPa) and A_0 (in sec), which are as follows:

$\mu \geq 0.03$; $\tau_0 \geq 0.60$ and $A_0 \geq 2.0 \times 10^{19}$.

14. (Amended) Process according to Claim 13, wherein the parameters μ, τ_0 and A_0 are as follows: $\mu \geq 0.047$; $\tau_0 \geq 0.90$ and $A_0 \geq 3.0 \times 10^{19}$.

15. (Amended) Process according to Claim 13, wherein the plastic used is also characterized by values for the parameters $T_{g,\,1\,atm}$ and $T_{g,\,600MPa}$ (in °C) which are as follows: $T_{g,\,1\,atm} \geq 30°C$, and $T_{g,\,600MPa} \geq 200°C$.

16. (Amended) Process according to Claim 15, wherein the parameter $T_{g,\,1\,atm}$ is as follows: $T_{g,\,1\,atm} \geq 70°C$.

17. (Amended) Wall-ironing tool comprising a wall-ironing ring, comprising a forming surface, along which a sheet-like product can be moved in a direction of movement during the wall

ironing, which forming surface is at an entry angle with respect to the direction of movement of the product, wherein the entry angle varies over the length of the forming surface, in the direction of movement of the product, this angle being smaller in a starting zone of the forming surface than in the subsequent zone thereof.

18. (Amended) Wall-ironing tool according to Claim 17, wherein the subsequent zone is an intermediate zone and the forming surface further comprises an end zone subsequent to the intermediate zone which is again at a smaller entry angle than in the intermediate zone.

19. (Amended) Wall-ironing tool according to Claim 17, wherein the forming surface further comprises an end zone, subsequent to the intermediate zone, and between the intermediate zone and the end zone there is a land zone with a length of between 0.3 and 1.5 mm.

20. (Twice Amended) Wall-ironing tool according to Claim 17, wherein the entry angle has a fixed value in each of the zones.

21. (Amended) (Amended) Wall-ironing tool according to Claim 17, wherein there is a smooth change in the entry angle over the length of the forming surface.

22. (Amended) Wall-ironing tool according to Claim 21, wherein the transitions between successive zone, and/or the zones themselves, run in the form of an arc of a circle with a radius of a length of between 0.1 and 10 mm.

23. (Amended) Wall-ironing tool according to Claim 17, wherein the zone having the largest entry angle, which is named a main zone, forms between 60 and 90% of the transverse dimension of the forming surface, transversely with respect to its longitudinal direction.

24. (Amended) Wall-ironing tool according to Claim 23, wherein the starting zone forms between 10 and 30% of the transverse dimension of the forming surface.

25. (Amended) Wall-ironing tool according to Claim 23, further comprising an end zone, subsequent to the intermediate zone, wherein the end zone forms less than 30% of the transverse dimension of the forming surface.

26. (Amended) Wall-ironing tool in the form of a wall-ironing ring, according to Claim 17, wherein this wall-ironing ring is under a radial prestress on its outer circumferential surface, due to a strip or wire which has been wound around the ring under stress.

REMARKS

Claims 1- 26 are pending.

This Preliminary Amendment makes editorial revisions to the specification.

Early and favorable consideration of this application are respectfully requested.

Respectfully submitted,

Date: Sept 24, 2001

By: [signature]
Anthony P. Venturino
Registration No. 31,674

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ATTACHMENT I - Marked up Claims

20. (Twice Amended) Wall-ironing tool according to [one of] Claim 17, wherein the entry angle has a fixed value in each of the zones.

1/parts

PROCESS FOR THE WALL IRONING OF A PRODUCT IN SHEET FORM, AND A WALL IRONING TOOL

The invention relates to a process for the wall ironing of a product in sheet form, which is formed from a metal sheet coated on at least one side with a layer of plastic, the wall-ironing tool comprising a forming surface which the product with a plastic coating layer moves along during the wall ironing, and the forming surface being at an entry angle with respect to the direction of movement of the product. A process of this nature is in widespread use for the production of a can comprising a base and a tubular body, although the invention is not limited to this particular application.

The entry angle forms an important parameter in wall ironing. It has been found that with a very small entry angle the spreading force, that is to say the force which acts on the forming surface transversely with respect to the direction of movement of the product, becomes very high. For example, in the case of wall ironing of cans, this may lead to extreme loads being imposed on the wall-ironing ring used, which may consequently be damaged or even break.

Selecting a larger entry angle runs the risk of the plastic layer breaking and being stripped off the metal sheet. This is because a larger entry angle results in a greater longitudinal force being exerted on the plastic layer in the direction of movement, with the result that the stress in the said plastic layer exceeds a fracture limit.

Proposals have previously been made for making the process more suitable for working with plastic-coated metal sheet. In European Patent EP 0,298,560, it is proposed that additional lubrication be used during the wall ironing, and specific entry angles are proposed for successive wall-ironing rings. Nevertheless, there is a continuing need to work with larger entry angles, in order to be able to achieve longer service lives of the wall-ironing tool. The present invention now offers a solution enabling the risk of the plastic layer breaking and being stripped off during wall ironing to be reduced, so that larger entry angles can be used.

The invention is based on making use of the observed fact that many plastics materials exhibit a higher fracture limit during forming as the pressure on all sides increases. The appended figure shows results of the correlation between the forming rate ($d\varepsilon/dt$ in s^{-1}), plotted on the horizontal axis, and the yield stress σ_v in MPa, plotted on the vertical axis, and the prevailing pressure P_0 in MPa on all sides. This figure works on the basis of a polyethyleneterephthalate (PET), with lines illustrating results of model studies and crosses indicating the results of experiments. It can be clearly seen from this figure that the yield stress is considerably higher as the pressure on all sides rises. The object of the invention is therefore to produce a high pressure on all sides at the location where the coated metal sheet is being wall-ironed using a large entry angle,

without it being necessary to apply a very high pressure to the entire wall-ironing installation.

The invention therefore consists in the fact that the entry angle varies over the length of the forming surface, in the direction of movement of the product past the forming surface, this entry angle being smaller in a starting zone of the forming surface than in the subsequent zone thereof. The result of his measure is that, in the starting zone with the small entry angle, a high pressure on all sides is built up in the material, and this pressure is maintained during the subsequent forming in the subsequent zone with a larger entry angle. In the zone where the actual forming takes place, a high pressure prevails on all sides, yet nevertheless a relatively low spreading force is exerted on the forming surface (for example a wall-ironing ring).

The high pressure which is generated on all sides in the plastic layer may relax slightly towards the chamber after the wall-ironing tool has been passed, towards the end of the zone with the larger entry angle. This may mean that the fracture stress of the plastic material is reduced again at that location, causing it to fracture and be stripped off by the wall-ironing tool. For this reason, it has proven advantageous for the forming surface in an end zone to again be at a smaller entry angle than in the intermediate zone.

An improvement is also achieved if the forming surface, following the zone with the largest entry angle, comprises a so-called land zone, with an entry angle of 0°. The length of this land zone may be between 0.3 and 1.5 mm.

In one possible application of the invention, the entry angle may have a fixed value in each of the said zones. However, under certain circumstances it may be preferable for the entry angle to change smoothly over the length of the forming surface. This prevents sudden changes in stress in the material to be wall ironed, so that, under certain circumstances, the wall ironing can proceed more successively.

In the preferred embodiment of this smooth change, the transitions between the successive zones, and/or the zones themselves, run in the form of an arc of a circle. Good results are obtained if the radius of this arc is between 0.1 and 10 mm long.

Particularly if the novel process is used for the wall ironing of a product which ultimately acquires the shape of a can, it is advantageous for the wall-ironing tool to comprise a plurality of wall-ironing rings of the type described above. In particular, it has proven advantageous for between 60 and 90% of the total wall thinning to be produced by the corresponding forming surface in the zone which runs at the largest entry angle, the so-called main zone. A further improvement is obtained if between 10 and 30% of the total wall thinning is produced by the corresponding forming surface in the starting zone. Furthermore, it is advantageous, if an end zone is also being used, for less than 30% of the total wall thinning to be produced by the corresponding forming surface in this end zone.

As explained above, it is possible, when using the novel process according to the invention, to use a larger entry angle in particular in the intermediate main zone, allowing the mechanical load on the forming surface, i.e. the wall-ironing ring, to be reduced. Despite this larger entry angle, it is generally possible, by using a starting zone and an end zone with a smaller entry angle, to prevent the plastic coating layer from yielding and being stripped off.

When using various plastics in various layer thicknesses and on various types and thicknesses of metal sheet, the limiting conditions for the entry angle in the intermediate zone and the entry angle and the length of the starting zone and the end zone will generally be different if it is desired to work using conditions which are optimal for all ironing without there being any risk of the plastic layer fracturing and being stripped off. It has been found that for various materials applications, the optimum conditions can be determined by means of experiments using forming surfaces (for example of wall-ironing rings) in which the length of the starting zone and/or the end zone is varied.

During the wall ironing of a plastic-coated metal sheet, the following functional relationship applies to the yield stress σ_v (in MPa) in the plastic:

$$\sigma_v = \frac{3}{\sqrt{3 + \mu}} \cdot [\tau_0 \ln(2\sqrt{3} \cdot A_0 \cdot d\varepsilon/dt) + \mu P_0], \text{ where:}$$

P_0 is the pressure in MPa prevailing on all sides in the plastic;

τ_0 is a base level for the yield stress in MPa;

$d\varepsilon/dt$ is the drawing speed of the plastic being formed in sec^{-1};

μ is a unit-free parameter which represents the pressure sensitivity of the plastic;

A_0 represents a time constant (in sec) which is related to the relaxation behaviour of the plastic.

According to the invention, it has been found that the wall ironing of a coated product in sheet form at an elevated pressure on all sides P_0 only takes place successively if the values of the parameters μ, τ_0 and A_0 of the plastic used for the coating satisfy specific boundary conditions. These values must be as follows:

$\mu \geq 0.03$; $\tau_0 \geq 0.60$ MPa and $A_0 \geq 2.0 \times 10^{19}$ sec.

It is preferable to use plastics in which the parameters are as follows:

$\mu \geq 0.047$; $\tau_0 \geq 0.90$ MPa and $A_0 \geq 3.0 \times 10^{19}$ sec.

It has been found that what is known as the glass transition temperature T_g of the plastic is important in the wall ironing of a plastic-coated metal sheet. T_g is the transition point for the properties of the amorphous range in the plastic. In principle, below T_g free movement of the main chain of the polymer is impossible. Above T_g, this freedom of movement is possible, leading to the hardness of the material falling by orders of magnitude. Since many plastics are partially crystalline, and this part partially retains its strength up to the melting point, many plastics materials can still be used very well up to temperatures far above T_g.

In the case of wall ironing, the level of T_g is important because the plastic must still have a relatively high mechanical strength during the wall ironing. A plastic coating with a low T_g may possibly acquire sufficient strength by building up a very high pressure in the wall-ironing tool. However, just outside this pressure zone the plastic is so "weak" that it is immediately pressed away and scrapped off.

During the wall-ironing process, a considerable rise in temperature takes place in the ironed material. This temperature may rise to approx. 200°C.

It has been found that a plastic-coated metal sheet can be successfully wall-ironed if the T_g of the plastic is sufficiently high under various conditions. The T_g at atmospheric pressure, $T_{g,\ 1\ atm}$, and the T_g when the plastic is under a pressure on all sides of 600 MPa, $T_{g,\ 600\ MPa}$, have proven particularly important in this context. According to the invention, $T_{g,\ 1\ atm}$ and $T_{g,\ 600\ MPa}$ must be as follows: $T_{g,\ 1\ atm} \geq 30°C$ and $T_{g,\ 600\ MPa} \geq 200°C$. Preferably, $T_{g,\ 1\ atm}$ must be as follows: $T_{g,\ 1\ atm} \geq 70°C$.

In addition to the process described above, the invention also relates to a wall-ironing tool, in particular a wall-ironing ring, comprising a forming surface, past which a sheet-like product can be moved during the wall ironing, which forming surface is at an entry angle with respect to the direction of movement of the product. This wall-ironing tool is characterized in that the entry angle varies over the length of the forming surface, in the direction of movement of the product, this angle being smaller in a starting zone of the forming surface than in the subsequent zone thereof.

Numerous preferred embodiments of the wall-ironing tool according to the invention have been explained in the preceding description of the novel process, to which reference is made here.

A particular preferred embodiment of a wall-ironing ring according to the invention is also that this wall-ironing ring is under a radial prestress on its outer circumferential surface, due to a strip or wire which has been wound around it under stress.

Wall-ironing rings are generally known, as are the associated terms such as entry angle, main zone and land zone.

Therefore, there is no need for the wall-ironing rings discussed to be explained in more detail in a description referring to figures.

CLAIMS

1. Process for the wall ironing of a product in sheet form, which is formed from a metal sheet coated on at least one side with a layer of plastic, the wall-ironing tool comprising a forming surface which the product with a plastic coating layer moves along during the wall ironing, and the forming surface being at an entry angle with respect to the direction of movement of the product, characterized in that the entry angle varies over the length of the forming surface, in the direction of movement of the product past the forming surface, this entry being smaller in a starting zone of the forming surface than in the subsequent zone thereof.

2. Process according to Claim 1, characterized in that the forming surface in an end zone is again at a smaller entry angle than in the intermediate zone.

3. Process according to Claim 1 or 2, characterized in that the forming surface, following the zone with the largest entry angle, comprises a so-called land zone, with an entry angle = 0°.

4. Process according to Claim 2 or 3, characterized in that the entry angle has a fixed value in each of the zones.

5. Process according to Claim 2 or 3, characterized in that there is a smooth change in the entry angle over the length of the forming surface.

6. Process according to Claim 5, characterized in that the transitions between successive zones, and/or such zones themselves run in the form of an arc of a circle.

7. Process according to one of the preceding claims, characterized in that the wall-ironing tool comprises a plurality of forming surfaces.

8. Process according to one of the preceding claims, characterized in that the wall-ironing tool comprises a plurality of wall-ironing rings.

9. Process according to one of the preceding claims, characterized in that 60 to 90% of the total wall thinning is produced by the corresponding forming surface in the zone running at the largest entry angle, the so-called main zone.

10. Process according to Claim 9, characterized in that 10 to 30% of the total wall thinning is produced by the corresponding forming surface in the starting zone.

11. Process according to Claim 9 or 10, characterized in that less than 30% of the total wall thinning is produced by the corresponding forming surface in the end zone.

12. Process according to one of the preceding claims, characterized in that the length of the starting zone and/or of the end zone, under otherwise identical conditions, is set in such a way that the plastic coating is not torn off the metal sheet as a result of the wall ironing.

13. Process for the wall ironing of a product in sheet form, which is formed from a metal sheet coated on at least one side with a layer of plastic, the wall-ironing tool comprising a forming surface which the product with a plastic coating layer moves along during the wall ironing, and the forming surface being at an entry angle with respect to the direction of movement of the product, characterized in that, in a zone of the forming surface which runs at the largest entry angle, the plastic layer is held under an elevated pressure P_0 (in MPa) on all sides, and that the plastic used for the coating layer is characterized by values of the parameters μ (no units); τ_0 (in MPa) and A_0 (in sec), as defined in the description, which are as follows:

$\mu \geq 0.03$; $\tau_0 \geq 0.60$ and $A_0 \geq 2.0 \times 10^{19}$.

14. Process according to Claim 13, characterized in that the parameters μ, τ_0 and A_0 are as follows: $\mu \geq 0.047$; $\tau_0 \geq 0.90$ and $A_0 \geq 3.0 \times 10^{19}$.

15. Process according to Claim 13 or 14, characterized in that the plastic used is also characterized by values for the parameters $T_{g,\ 1\ atm}$ and $T_{g,\ 600\ MPa}$ (in °C), as defined in the description, which are as follows: $T_{g,\ 1\ atm} \geq 30°C$ and $T_{g,\ 600\ MPa} \geq 200°C$.

16. Process according to Claim 15, characterized in that the parameter $T_{g,\ 1\ atm}$ is as follows: $T_{g,\ 1\ atm} \geq 70°C$.

17. Wall-ironing tool, in particular a wall-ironing ring, comprising a forming surface, along which a sheet-like product can be moved during the wall ironing, which forming surface is at an entry angle with respect to the direction of movement of

the product, characterized in that the entry angle varies over the length of the forming surface, in the direction of movement of the product, this angle being smaller in a starting zone of the forming surface than in the subsequent zone thereof.

18. Wall-ironing tool according to Claim 17, characterized in that the forming surface in an end zone is again at a smaller entry angle than in the intermediate zone.

19. Wall-ironing tool according to Claim 17 or 18, characterized in that between the intermediate zone and the end zone there is a land zone with a length of between 0.3 and 1.5 mm.

20. Wall-ironing tool according to one of Claims 17-19, characterized in that the entry angle has a fixed value in each of the zones.

21. Wall-ironing tool according to one of Claims 17-19, characterized in that there is a smooth change in the entry angle over the length of the forming surface.

22. Wall-ironing tool according to Claim 21, characterized in that the transitions between successive zone, and/or the zones themselves, run in the form of an arc of a circle with a radius of a length of between 0.1 and 10 mm.

23. Wall-ironing tool according to one of Claims 17-22, characterized in that the main zone forms between 60 and 90% of the transverse dimension of the forming surface, transversely with respect to its longitudinal direction.

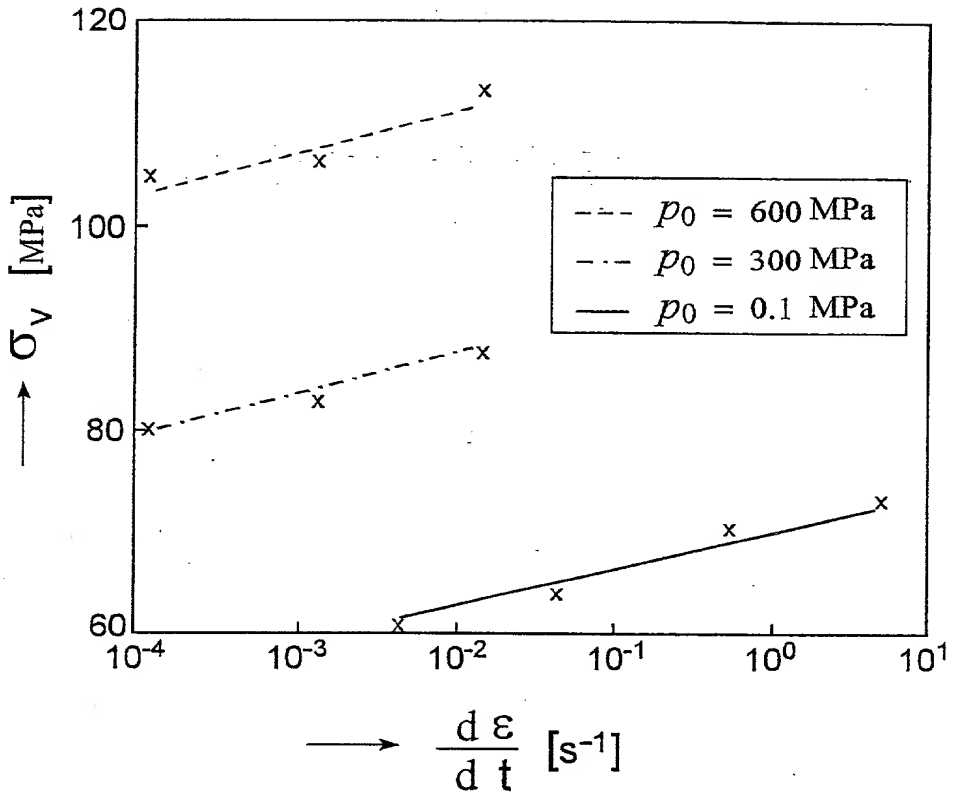
24. Wall-ironing tool according to Claim 23, characterized in that the starting zone forms between 10 and 30% of the transverse dimension of the forming surface.

25. Wall-ironing tool according to Claim 23 or 24, characterized in that the end zone forms less than 30% of the transverse dimension of the forming surface.

26. Wall-ironing tool in the form of a wall-ironing ring, according to one of Claims 17-25, characterized in that this wall-ironing ring is under a radial prestress on its outer circumferential surface, due to a strip or wire which has been wound around it under stress.

ABSTRACT

Process for the wall ironing of a product in sheet form, which is formed from a metal sheet coated on at least one side with a layer of plastic, the wall-ironing tool comprising a forming surface which the product with a plastic coating layer moves along during the wall ironing, and the forming surface being at an entry angle with respect to the direction of movement of the product, whereby the entry angle varies over the length of the forming surface, in the direction of movement of the product past the forming surface, this entry being smaller in a starting zone of the forming surface than in the subsequent zone thereof.



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As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; that

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural inventors are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

PROCESS FOR THE WALL IRONING OF A PRODUCT IN SHEET FORM, AND A WALL IRONING TOOL

the specification of which (check one)

[ ] is attached hereto.

[X] was filed on August 31, 2001 as Application Serial No. 09/914,645 and was amended on N/A. (if applicable)

[ ] was filed as PCT International Application No. ____ on __, and was filed in the U.S. National Stage on ____ as U.S. Patent Application No. ____.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

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Prior Foreign and U.S. Provisional Application(s)			Priority Claimed	
1011437 (Number)	Netherlands (Country)	3 March 99 Day/Month/Year Filed	[X] Yes	[ ] No
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I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith; Stevens, Davis, Miller & Mosher, L.L.P.; Anthony P. Venturino, Reg. No. 31,674; James E. Ledbetter, Reg. No. 28,732; and Thomas P. Pavelko, Reg. No. 31,689. Direct all telephone calls to telephone no. 202-785-0100 and faxes to 202-408-5200.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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